

# INFORMATION SHEET

## ACOUSTIC PERFORMANCE

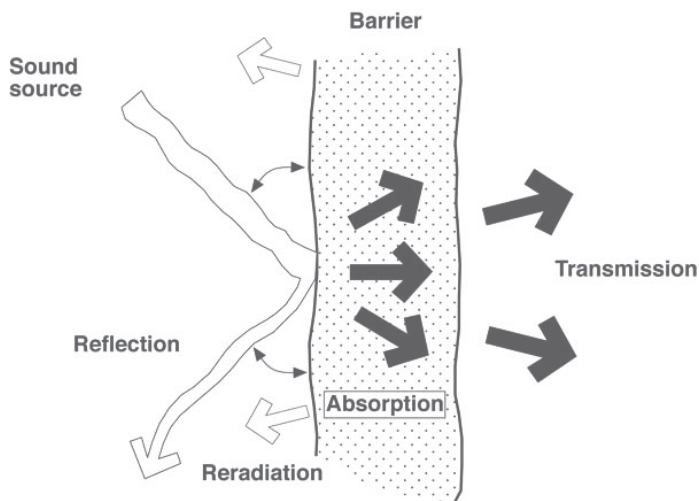
### DESIGN REQUIREMENTS FOR SOUND REDUCTION

The information provided below has been taken from the New Zealand Timber Design Guide 2007, published by the Timber Industry Federation and edited by Professor A H Buchanan. To purchase a copy of the Timber Design Guide, visit [www.nztif.co.nz](http://www.nztif.co.nz)

When sound meets a barrier or wall, three things take place: the sound is transmitted, absorbed or reflected, as shown in diagram 1.

Porous materials are usually used to control the absorption and reflection components of sound.

**Diagram 1: Reflection, absorption and transmission of sound meeting a barrier**



#### ABSORPTION

Porous materials, such as fibreglass or mineral wool, must be sufficiently open to allow the sound wave to enter the air-containing channels, yet sufficiently closed to present a reduction to the wave motion in these channels.

The sound energy is absorbed by being converted into heat via frictional losses in porous or fibrous material. This material is placed within noise control walls primarily to reduce cavity resonances. The key material properties are usually airflow resistance and thickness.

#### TRANSMISSION LOSS

Transmission loss (TL) is the ability of a material to reduce or resist the transmission of sound. Many of the principles in sound transmission are shown if a single layer of non-porous homogeneous partition (such as particle board or gypsum plasterboard) is considered.

At a given frequency, for a sound that is randomly incident to the panel, the transmission loss is given by:

$$TL = 20\log(Mf) - 47.2\text{dB}$$

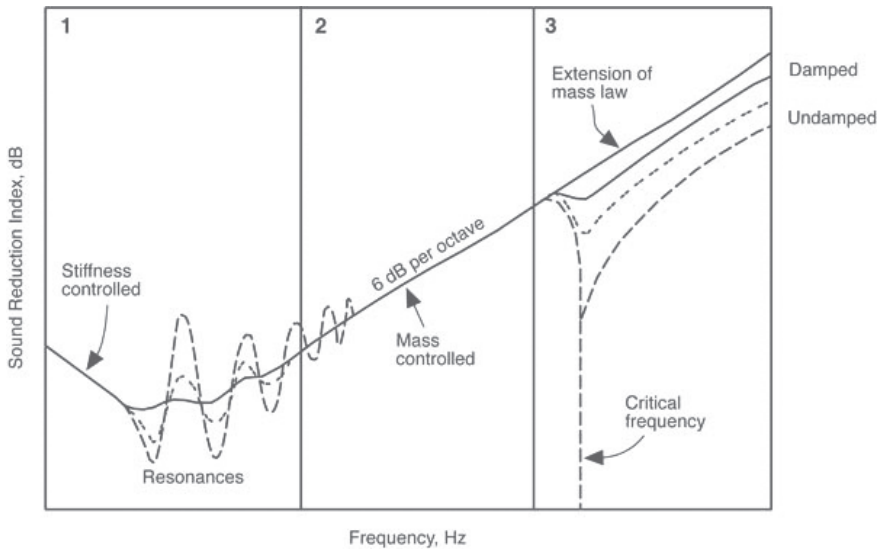
where  $M$  is the mass of the partition in  $\text{kg/m}^2$  and  $f$  the frequency of interest. This relationship is known as the mass law and, as can be seen from this formula ( $20 \log 2 = 6$ ), each time the mass is doubled the transmission loss increases 6 decibels (dB).

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Similarly, as the frequency doubles so the transmission loss increases by 6 dB. Therefore, it is the low frequencies that usually present design problems because a high mass is required for  $20 \log(Mf)$  to give a reasonable transmission loss.

It is important to understand some unusual characteristics in the TL values in order to be successful in achieving noise reduction. Diagram 2 represents the typical frequency response of a single partition showing three distinct performance regions.

**Diagram 2: Typical frequency response of a partition, showing three performance regions**



In region 1, at low frequencies, the panel tends to bend as the sound waves strike the panel, so its performance is dependent on its stiffness.

In region 2, the mass law applies with a reasonable degree of accuracy. However, in region 3 an effect known as the 'coincidence dip' occurs. This happens when sound with a frequency above the so-called 'critical frequency' strikes a panel at an oblique angle and is able to efficiently transfer its energy to the panel.

The reason for this increased sound energy transfer above the critical frequency is complicated, and is not explained further here. However, the practical result is that, at the coincidence dip, the TL expected from the mass law may be reduced by as much as 15 dB. This is important for most building materials, because the reduction in TL can occur in a frequency of interest, for example, in the 1 kilohertz (kHz) region for 12 mm glass.

In general, the greater the bending stiffness of the material and the less dense it is the lower the critical frequency and the more influential the coincidence dip. Damping also plays a role in reducing the severity of the coincidence dip effect. So, where high performance TL is required, a flexible material with a dampening effect is usually preferred. Lead is a good example of such a material, although there may be other practical problems with its use.

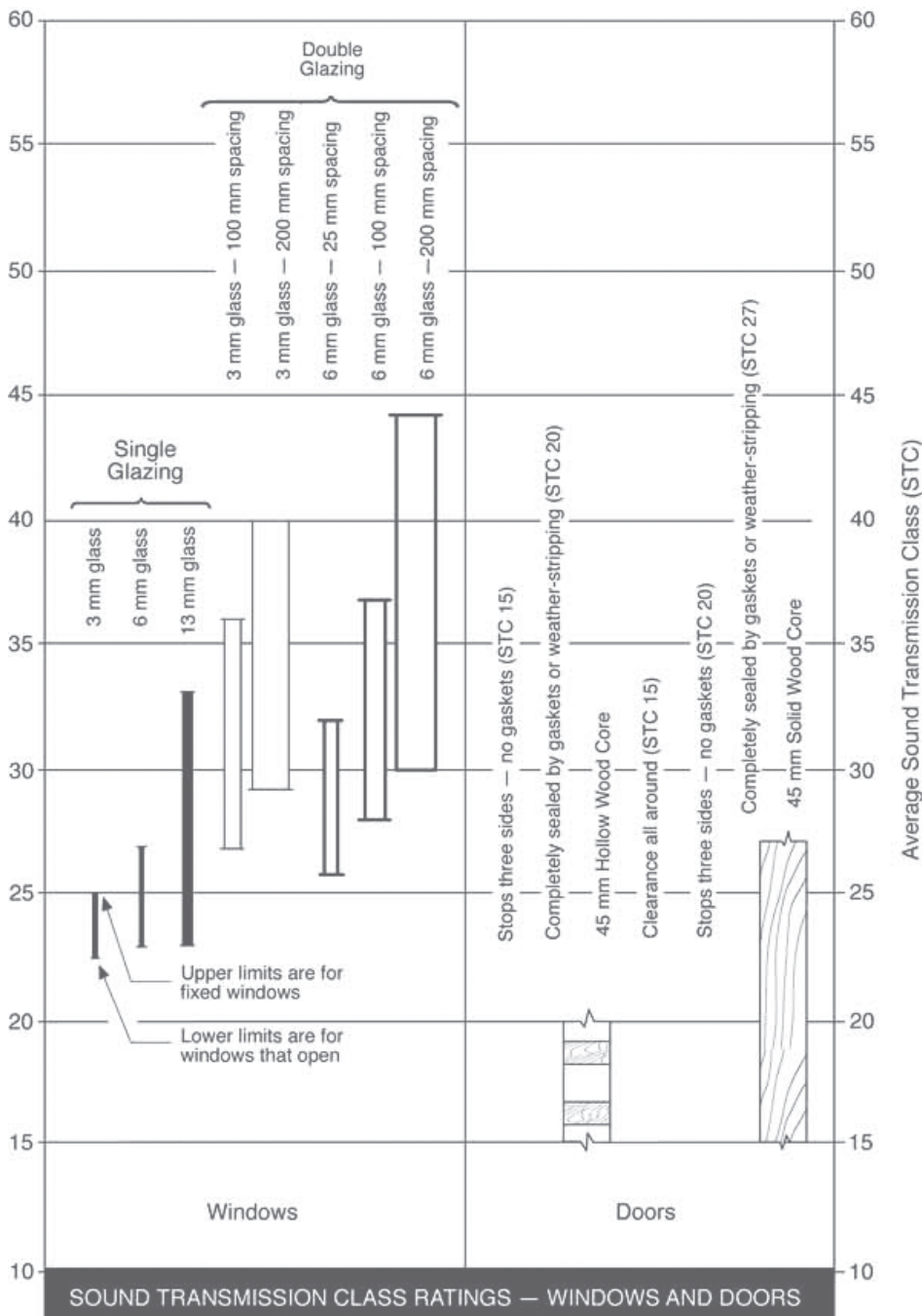
Another way around this problem is to use a double wall, with each side having a different thickness of material and, therefore, a different critical frequency. It should be noted that there is no such thing as an ultra light, high-efficiency acoustic partition; weight is of prime importance in the design to achieve sound reduction.

**SINGLE NUMBER RATINGS FOR TRANSMISSION LOSS**

It is difficult to describe the transmission loss characteristics of a partition by a single number rating. However, a single number rating is useful for general categorisation of partitions and can be used to narrow the number of wall configurations that must be analysed in detail before one is selected for a given situation.

The single number rating used is the sound transmission class (STC) rating. To determine the STC rating of a wall assembly, the measured transmission loss values in the contiguous 16 one-third octave frequency bands between 125 hertz (Hz) and 4,000 Hz are compared with the values of an STC reference curve. The STC value may loosely be thought of as the average value of the transmission loss. Diagram 3 shows the STC values for a range of window and door designs.

**Diagram 3: Typical STC ratings for windows and doors**



Source: Courtesy of the Canadian Wood Council